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ABSTRACT

This publication describes in nontechnical language the problem of pesticide use and how it affects water quality. It provides information on laws affecting pesticide use and the reasons for them, as well as giving directions for the proper use of pesticides. The booklet is divided into five chapters, each of which concludes with a list of study questions (answers at back of book). Chapter 1 introduces the problem of pesticide use and water quality. Chapters 2 and 3 describe the types of pesticides available, their uses, their toxicity and hazards, and safety precautions. Chapter 4 takes up the subject of pesticides and the environment, and suggests methods of pesticide storage and disposal. The final chapter describes an integrated approach to pest management practices--control by cultural, biological, and chemical methods. A reference section is included in the publication. (KC)

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PESTICIDE USE AND WATER QUALITY

U.S. DEPARTMENT OF HEALTH
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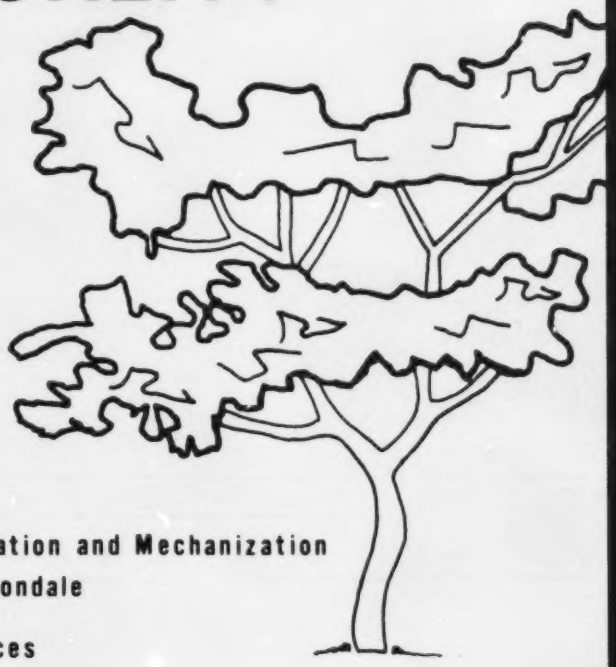

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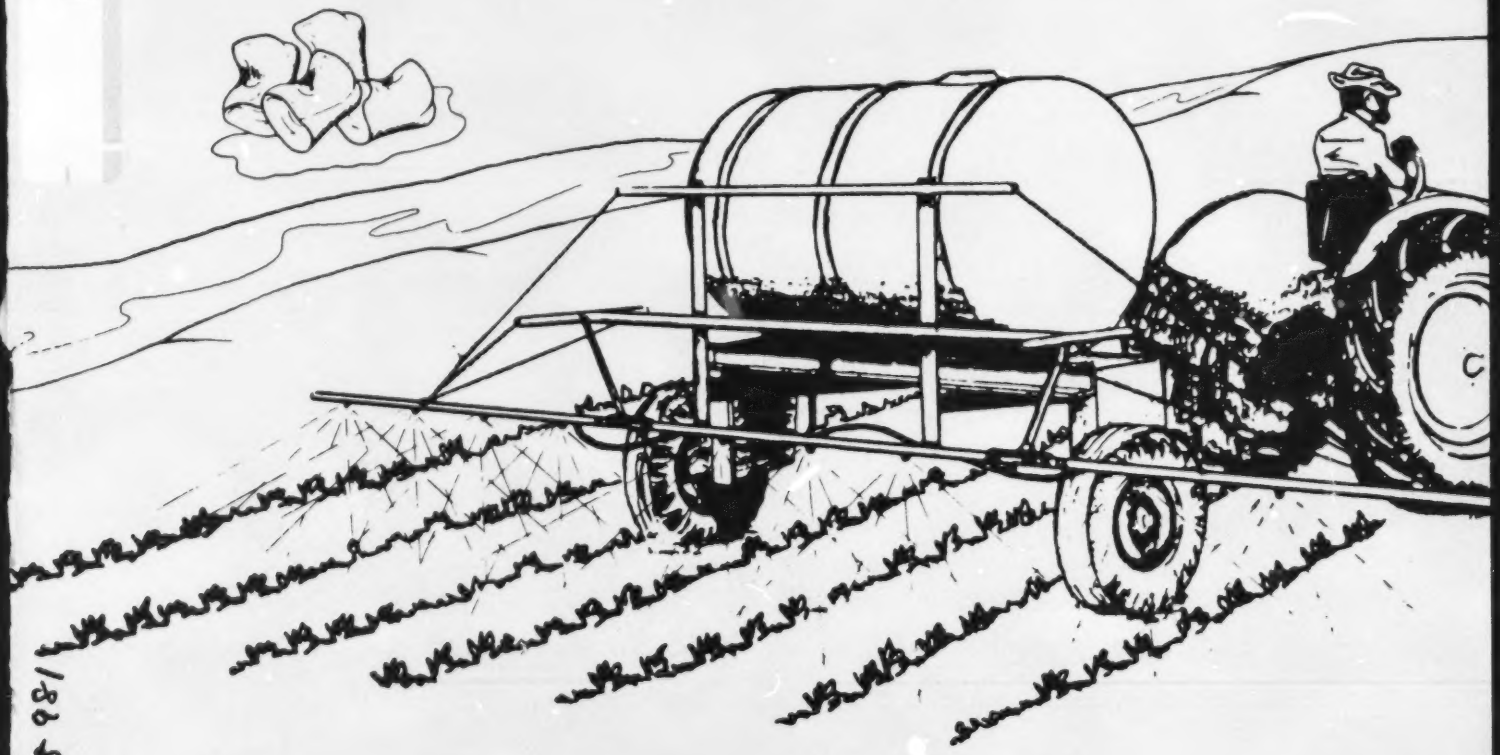

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Pesticide Use and Water Quality

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January 1981

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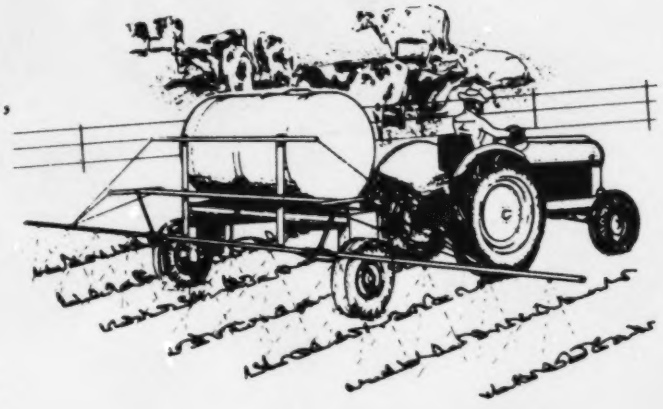
CHAPTER 1

Pesticides and Water Quality

Pesticides and water quality are essential. Pesticide use is essential to profitable crop production, and water quality is essential to the survival of human, plant, animal, and aquatic life in the environment.



The American farmer has continued to exceed the food and fiber needs of the United States. Pesticides have played a major role in improving the yields and quality of agricultural products.

The use of pesticides on agricultural crops has resulted in economic benefits to the farmer and higher quality products to the consumer. Chemical pesticides will continue to be an integral part of the agricultural industry in the coming decade. .

Although pesticide use benefits the production of agricultural products, pesticides can have adverse effects on the environment.

Much of the pesticide damage to the environment results from misuse of pesticides.

Protection of the environment (water, soil, and air) is essential to the existence of human, animal, and plant life. Pesticides help man control pests and plant diseases in the environment. This provides man with a greater potential for the production of food and fiber. Hazardous conditions in the environment arise when pesticides are stored, utilized, or disposed of improperly. Pesticides can harm the environment in several ways. They can:

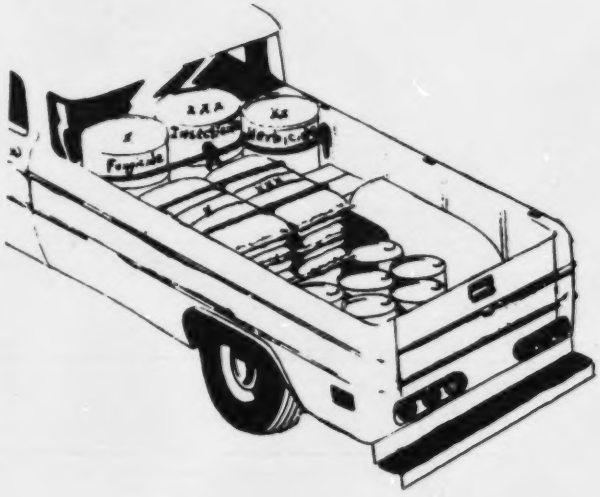
1. pollute water sources (rivers, streams, wells),
2. contaminate crops,
3. pollute soil,
4. create residue build-up in animals, birds, humans, or
5. cause nature imbalance.

The potential movement of chemical pesticides into water is an environmental concern. Sound pesticide management practices and knowledge of pesticides are essential to maintaining water quality.

The Ohio and Mississippi river systems form over half of Illinois' borders. There are many lakes and streams (large and small) which make up Illinois' water resources. Pollution of these water sources by pesticides must be minimized.

The Federal Water Pollution Control Act Amendment of 1972, was passed to control environmental pollution. The Law (Public Law 92-500) gave the Federal Environmental Protection Agency (U.S. EPA) a mandate to restore and maintain the quality of the nation's water resources. As of May 1, 1980, it is illegal to transport or dispose of any unidentified hazardous waste. All containers of hazardous waste must be labeled with their ingredients and concentrations. Transportation of hazardous materials

from Illinois' retailers to farmers requires no special labelling, if quantities do not exceed 5,000 pounds or 500 gallons of formulated pesticide.



Hazardous waste is defined as any substance with concentrations of pollutants greater than ten times the allowable levels set under the Safe Drinking Water Act. There are 25,000 hazardous waste generators in Illinois. Each hazardous waste generator is required to register the name of the hazardous waste produced, its quantity, hazard class, origin, routing, and destination.

The Federal Insecticide Fungicide Rodenticide Act (FIFRA) requires the federal registration of all pesticides by the U.S. EPA. The FIFRA allows two exceptions, they are: 1) emergency exemption and 2) intrastate use to meet special needs. Any applicator may be found in violation of the Pesticide Control Law if such person has:

> "Caused the poisoning, ruining, spoiling, or making uninhabitable for man or animals any piece of land or body of water by use, application, or disposal of pesticides in a faulty, careless, illegal or negligent manner."

The Illinois Environmental Protection Agency (IEPA) was established in 1970 with the passage of the Environmental Protection Act.

The Act specifically states, no person shall:

1. Discharge any contaminants into the environment so as to cause or tend to cause water pollution in Illinois;
2. Construct, install, or operate any equipment, facility, vessel, or aircraft capable of causing or contributing to water pollution;
3. Deposit any contaminants upon the land in such place and manner so as to create a water pollution hazard;
4. Discharge any contaminant into Illinois water resource; this includes sewage works, well, lakes, and all other water sources.

Rule 203 General Standards of the Water Pollution Control Regulations is designed to protect Illinois water resources. The water standards are:

1. Freedom from unnatural sludge or bottom deposits, floating debris, visible oil, odor, unnatural plant or algal growth, unnatural

color or turbidity, or matter in concentrations or combinations toxic or harmful to human, animal, plant, or aquatic life of other than natural origin.

2. Any substance toxic to aquatic life shall not exceed one tenth of the 96-hour median tolerance limit for native fish or essential fish food organisms except for U.S. EPA registered pesticides approved for aquatic application.
3. Before a pesticide is applied to waters of the State, where the pesticide will have an adverse effect on public or food processing water supplies, a permit must be obtained from the Illinois EPA.

The Division of Public Water Supplies of the Illinois Environmental Protection Agency monitors the treated surface water for pesticide contamination. One hundred and forty treated surface sites are analyzed once every five months for pesticide contaminants.

KEY QUESTIONS

CHAPTER 1

1. Pesticides have played a major role in improving the yields and quality of _____ products.
2. The use of pesticides on agricultural crops has resulted in economic benefits to the farmer and higher quality product to the _____.
3. Pesticides can have adverse effects on the _____.
4. Sound pesticide management practices are essential to maintaining _____ quality.
5. The Federal Water Pollution Control Act of 1972 gave the Federal EPA a mandate to restore and maintain the _____ of the nation's water resources.
6. Disposal of _____ in a faulty, careless, illegal or negligent manner is a violation of the law.
7. The Illinois Environmental Protection Agency monitors the treated surface _____ for pesticide contamination.

ANSWERS ARE LISTED IN THE BACK OF THE BOOKLET UNDER CHAPTER 1.

CHAPTER 2

Pesticides Use

Pesticides are chemicals used to destroy, prevent, or control pests. They interrupt or suppress normal life functions in living organisms. It is this quality that helps farmers produce food at the present high level. Most pesticides fall into three major types: insecticides, herbicides, and fungicides. Other types of pesticides include: rodenticides, miticides, and nematicides.

Types of Pesticides

Insecticides. Chemicals used to control insects and other related animals such as ticks, spiders, and centipedes are known as insecticides. Insecticides vary in the length of time they are effective as killing agents. Non-residual insecticides, used where a hazard to non-target organisms such as people, pets, other domestic animals, honeybees or wildlife exists, rapidly break down into non-toxic by-products. Residual insecticides, used for long-term control and where no danger of injury to non-target organisms exists, remain active for a long time.

Herbicides. Herbicides are chemicals formulated to kill plant life. Herbicides are classified as selective or non-selective, according to their use. A selective herbicide is one

which kills undesirable plant species with little or no damage to agronomic, vegetable, turf, or ornamental crops. A non-selective herbicide is toxic to all plants. They are used where selectivity is not intended.

Fungicides. Fungicides are used to prevent or control fungi which cause plant diseases. Narrow spectrum fungicides are effective against a few fungi, while broad spectrum fungicides are effective against a wide range of fungi.

Surface protectant fungicides are used to prevent infections by covering the plant surface to protect a plant against infection. Systemic fungicides are absorbed into the plant tissues. Surface protectants are used in preventing infection; whereas, systemics can be used as either a protectant or to treat infected plants.

Other Pesticides. Rodenticides, miticides, and nematicides are used in smaller amounts than the major pecticides. Although these pesticides are used in less quantities, they can be just as harmful to the environment.

Pesticide Toxicity and Hazards

Toxicity is the capacity of a pesticide to produce injury or death. Pesticide toxicity is expressed in LD_{50} and LC_{50} numbers. These numbers give information on how much of a pecticide, by weight, is required to kill. LD_{50} is the lethal dosage that will kill 50 percent of the test animals if a pesticide is eaten or absorbed through the skin. LC_{50} is the lethal concentration that will kill 50 percent of the test animals by inhalation (breathing).

LD_{50} and LC_{50} are seldom displayed on a pesticide label. Key words are used to describe the pesticide toxicity rating. These

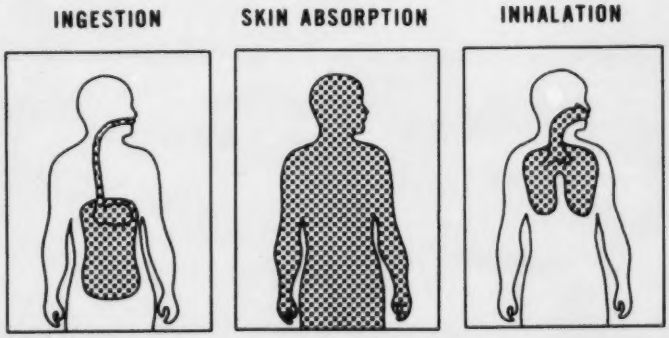
key words are given in the following chart.

PESTICIDE TOXICITY RATING

Toxicity Rating	Label Signal Key Words	Oral LD_{50} (mg/kg)	Dermal LD_{50} (mg/kg)	Inhalation LC_{50} (ppm)
High	Danger-Poison	0-50	0-200	0-2,000
Moderate	Warning	51-500	201-2,000	2,001-20,000
Slightly Toxic	Caution	501-5,000	2001-20,000	over 20,000
Relatively Nontoxic	Caution	over 5,000	over 20,000	- - - - -

Pesticides derive much of their value from inherent ability to disrupt normal functions in living organisms. Unfortunately, these desirable characteristics can affect humans causing sickness, injury, or death.

Knowing how people are poisoned by pesticides can reduce the probability of an accident occuring. There are three ways a pesticide can enter the body. They are: 1) ingestion (oral), 2) skin absorption (dermal), and 3) inhalation (breathing).



Pesticide ingestion is the cause of most pesticide deaths. This is frequently the result of

irresponsible individuals who store pesticides in containers other than the original pesticide container or fail to secure the pesticides under lock. Oral poisonings also can occur when applicators accidently poison themselves by eating, smoking, or drinking with contaminated hands. The seriousness of these poisonings is dependent on the oral LD_{50} of the pesticide in question and the amount swallowed.

The amount of pesticide required to cause death depends on the toxicity. This can vary from a few drops to a few tablespoons depending on the pesticide LD_{50}.

Pesticides which are absorbed through the skin have a dermal toxicity. Dermal exposure can occur anytime a pesticide is handled, mixed, or applied. The seriousness of the exposure depends on four factors: 1) the dermal toxicity of the chemical, 2) the rate of absorption through the skin, 3) the size of the area contaminated, and 4) the length of exposure. Dermal toxicity can be expressed in LD_{50}'s but most frequently is expressed as low, moderate, or high.

The rate at which a pesticide penetrates the skin varies with the area of the body exposed. The longer a pesticide is in contact with the skin, the greater the hazard.

Inhalation exposure occurs when one breathes pesticide vapors, dusts, or spray particles. It is more common in greenhouses and enclosed areas, but can occur out of doors when respirators are not used. The smoke of burning containers or smoking contaminated cigarettes can produce toxic exposure.

Pesticide hazard is the probability that injury will result from using a pesticide in a particular quantity and manner. Hazards may involve humans, animals, plants, and aquatic life since pesticides may accidently poison non-target areas.

Evaluation of hazards requires differentiating between operational hazards and food hazards. Operational hazards are those encountered in the application of pesticides. They are minimized by applicators following the directions on labeled containers. Pesticide manufacturers, government agencies, and the applicators are responsible for minimizing operational hazards.

A food hazard is related to the persistence of a pesticide. A persistent pesticide is one that remains toxic to living organisms over an extended period of time. When these are applied to crops, a residue may remain in or on the food product. The probability that poisoning will result from residues is the food hazard.

The U.S. EPA has established tolerance limits for pesticide residues. Food tolerances are monitored by the United States Department of Agriculture and the Illinois Department of Agriculture.

Pesticide residues can result from direct application, drift from nearby field applications, plant uptake from contaminated soil, runoff and/or other sources.

KEY QUESTIONS

CHAPTER 2

1. Pesticides are _____ used to destroy, prevent, or control pests.
2. Pesticides used to control insects, ticks, spiders, and centipedes are known as _____.
3. Herbicides are chemicals formulated to kill _____ life.
4. Chemicals are used to prevent or control fungi which cause plant _____.
5. The Illinois Environmental Protection Agency (IEPA) is responsible for investigating sources of pesticide _____.
6. LD_{50} is the _____ dosage that will kill 50 percent of the test animals if a pesticide is eaten or absorbed through the skin.
7. LC_{50} is the lethal concentration that will kill 50 percent of the test animals by _____.
8. The pesticide label key words "Danger - Poison" means that the chemical has a _____ toxicity rating.
9. A pesticide can poison a person by inhalation, skin absorption, and _____.
10. Most pesticide deaths are a result of pesticide _____.

11. The amount of pesticide causing death depends on the _____ of the chemical.
12. The longer a pesticide is in contact with the skin, the greater the _____.
13. _____ exposure occurs when one breathes pesticide vapors, dust, or spray particles.
14. The U.S. EPA has established tolerance limits for pesticide _____.

ANSWERS ARE LISTED IN THE BACK OF THE BOOKLET UNDER CHAPTER 2.

CHAPTER 3

Pesticide Safety

The safe use of pesticides is essential to the health of human beings, animals, plants, and aquatic life in the environment. Pesticide use can be a life and death proposition. It is the applicator's responsibility to use pesticides as recommended and under conditions favorable for the most effective control of the pest, with a minimal negative impact on the surrounding environment.

The Pesticide Label

Chemical companies spend approximately $10 million in testing and preparing each new pesticide for market. This research and development cost is associated with an analysis of the environmental impact resulting from the application and use of a pesticide. By law (FIFRA) chemical companies are required to display specific information on the pesticide container label. Applicators are required by law to use a pesticide in accordance with the label's directions. In accordance with the law, the label must contain the following information.

Use Classification. The use classification statement is assigned by the U.S. EPA classifying the chemical for general use or restricted use. A general use classification indicates that the

chemical is not likely to harm the applicator or the environment when used as directed. A restricted use pesticide may harm the applicator and the environment even though it is used as directed and therefore, may be sold only to licensed applicators.

Trade or Brand Name. The trade or brand name is the manufacturer's name for the product. Trade names vary from company to company. For example, Cythion and Malatox are trade names for the insecticide malathion.

Ingredients. The amounts of active and inactive (inert) ingredients in the formulation must be included on the label.

Net Contents. The amount of pesticide in the container may be expressed in gallons, quarts, pints, pounds, metric or other units of measure.

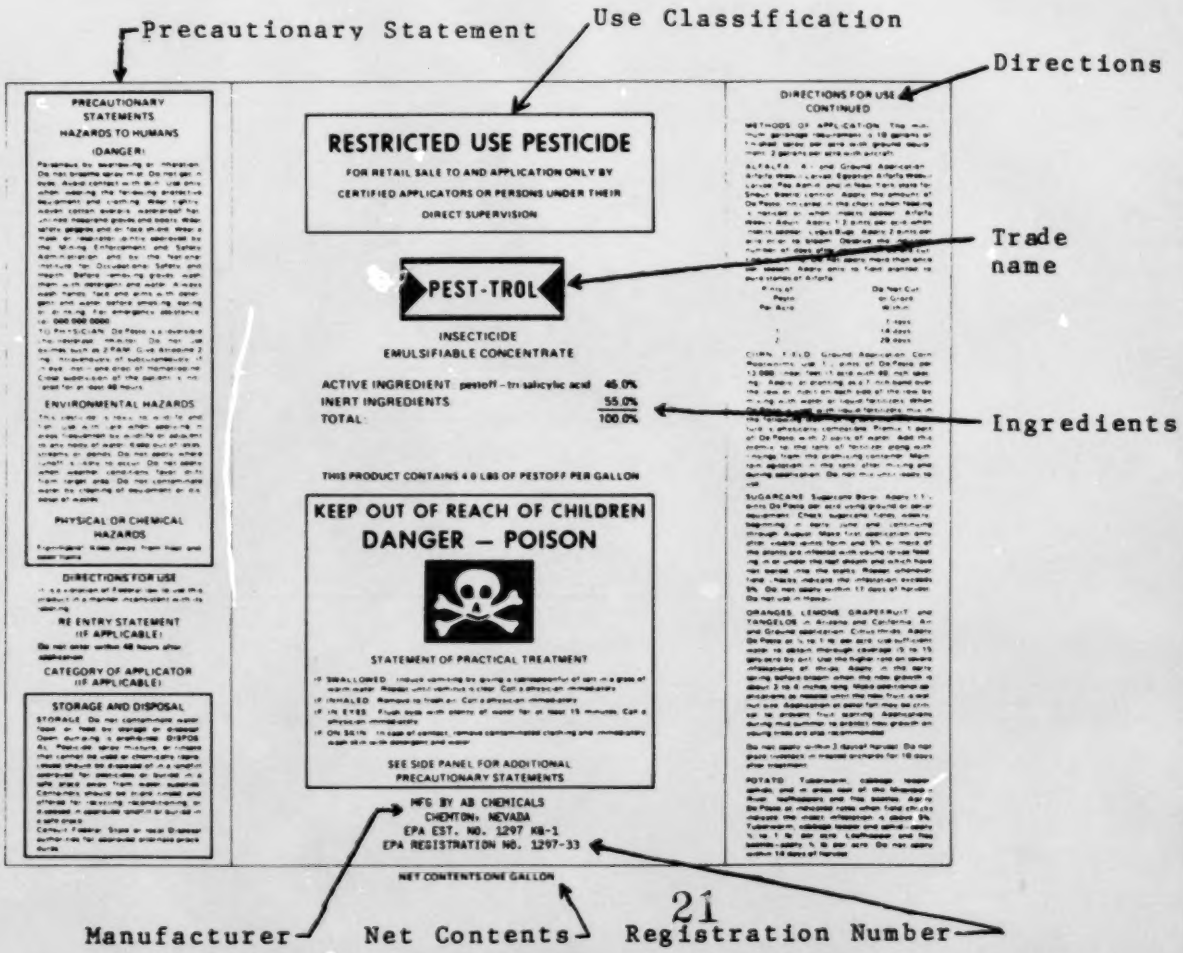
Precautionary Statements. The precautionary statements indicate the potential hazard to the applicator, other human beings, animals, and to the environment. The key words are: Danger-Poison (skull and crossbones - highly toxic), Warning (moderately Toxic), or Caution (low toxicity). The precautionary statements also include practical first aid treatements in case of chemical exposure. The human and animal hazards statement will identify mode of poisoning, what to do to prevent poisoning, and notice to physician for antidotal treatment. The hazards to the environment and humans statement will identify the nature of specific hazards and what to do to avoid damage to non-target areas. The physical or chemical hazards statement indicates whether the pesticide is flammable or explosive.

Directions for Use. The general use or restricted use classification will be followed by: 1) the pests controlled, the crop

treated, the recommended amount to use, and the frequency and time of application, 2) re-entry statement, indicating length of time prior to re-entry into the treated area, 3) storage and disposal directions, 4) directions for application, and 5) restrictions on use of the pesticide.

Registration and Establishment Numbers. The registration number indicates the pesticide has been registered with the U.S. EPA. The use of an unregistered pesticide is illegal. The U.S. EPA establishment number is an identification number used to indicate the factory which produced the pesticide.

Name and Address of Manufacturer. This provides the applicator with the name and address of the company to call in case of an accident.



Mixing Pesticides

Pesticides used for agricultural purposes are often purchased in a concentrated form. Concentrated pesticide must be diluted before use on crops and/or animals. The applicator is exposed to a hazard during the mixing and loading process. The knowledge and use of safety procedures (precautions) are essential to reduce exposure to a pesticide which can result in an accident, injury, or death.

When handling pesticides, always wear protective clothing. This includes such items as goggles, respirator, gloves, aprons, and protective suits. Read the label's directions before handling the pesticide. Highly concentrated chemical pesticides present a greater degree of hazard during the mixing process than during the application of the diluted pesticide to the target area.

Toxic pesticides should be mixed outdoors. Ventilation is essential when mixing pesticides. Pour the pesticide slowly from the container to keep the pesticide from splashing and spilling outside of the mixing tank. The container should be held below the eyes and face to avoid needless exposure. Calculate the correct dosage for the target area to avoid needless waste of pesticide left in the tank.

Protective Clothing and Equipment

Remember, if concentrated or diluted pesticide is spilled on the skin, stop immediately, remove clothes, and wash skin with soap and water. Do not smoke, eat, drink, or place hands into the mouth during the mixing, loading, and application activities.

Environmental hazards exist where careless mixing and loading procedures are followed. Overfilled tanks or excess diluted pesticides create a pollution problem.

Key points to remember:

1. Select correct pesticide for job.
2. Wear protective clothing as directed on pesticide label.
3. Read and follow directions on pesticide label.
4. Calculate amount of diluted pesticide needed.
5. Never work alone when handling toxic pesticides.

Pesticide Application

Pesticide applicator is the term used to identify an individual who applies pesticides to plants or animals. There are two basic groups of applicators. They are: 1) commercial applicators and 2) private applicators. A commercial applicator is anyone who treats a target area with pesticides for pay. A private applicator is any individual who treats a target area with pesticides for no pay. The private applicator includes such individuals as farmers, home owners, and renters.

Both private and commercial applicators must be certified by the Illinois Department of Agriculture before they can purchase or apply restricted pesticides. However, private applicators do not have to be certified to apply general use pesticides. County extension advisors often conduct the training sessions for private and commercial operator's certification. Contact the local county extension advisor for additional information.

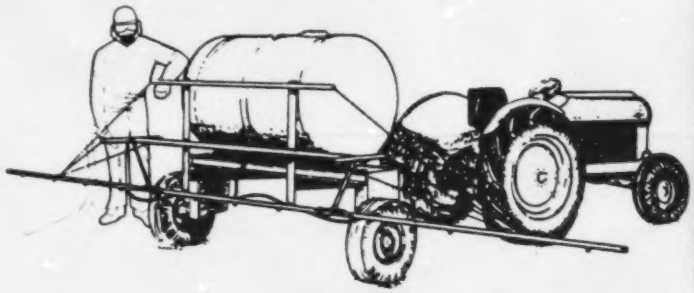
The pesticide applicator is responsible for protection of self, other humans, plants, animals, and water resources in the environment. Environmental hazards such as pesticide contamination of ponds, lakes, streams, and rivers exist where pesticides are carelessly applied. The pesticide applicator assumes tremendous responsibility when using chemicals to control a pest problem.

Clean, non-polluted water is needed by all; it is essential for man, plants, animals, and aquatic life. Pollution of Illinois water resources will have adverse effects on the environment. One of the problems associated with pesticide use is that of keeping pesticides out of ground and surface waters.

The following suggestions will aid the pesticide applicator in minimizing the danger of pesticide contamination of non-target areas:

- Do not work in pesticide drift or runoff.
- Do not eat, drink, or smoke before washing with soap and water.
- Notify beekeepers and residents when pesticides are to be used in the area.
- Keep people away from spray area, work area, and spray equipment.

- Check weather conditions before pesticide application.
- Do not apply pesticide before a rain.
- Work in pairs when handling toxic pesticides.
- Avoid application in sensitive areas such as houses, schools, hospitals, playgrounds, water sources, and around sensitive crops. Spray these areas on a calm day.
- Avoid application when drift may be a serious problem.
- Avoid spray area until safe re-entry date.
- Have regular medical check-ups when applying pesticides frequently.
- Do not spray near streams, ponds, or wells.



The job of applying pesticides is not completed until all exposed personnel and equipment are cleaned. Cleanup is essential to avoid human poisoning and environmental contamination. Persons exposed to pesticides should shower and thoroughly scrub all portions of the skin and scalp with soap and water. Contaminated clothing should not be worn again until washed with soap. Wash exposed clothing separate from all other clothes.

KEY QUESTIONS

CHAPTER 3

1. The applicator is responsible for using pesticides as recommended and under conditions suitable to the most effective control of the _____.
2. Applicators are required by law to use pesticides in accordance with the _____directions.
3. A general use classification indicates that the chemical is not likely to harm the applicator or the _____ when used as directed.
4. The U.S. EPA classifies a pesticide chemical as "general" use or as "_____" use.
5. Concentrated pesticide must be _____before use on crops and/or animals.
6. Environmental hazards exist where careless _____ and loading procedures are followed.
7. Private and _____applicators must be certified by the Illinois Department of Agriculture before they can purchase or apply _____pesticides.
8. One of the problems associated with water pollution is that of keeping pesticides out of ground and _____ _____waters.
9. The pesticide applicator assumes tremendous responsibility when using chemicals to _____a pest problem.

10. Toxic chemicals released into the environment have a potential for serious pollution of Illinois _____ resources.

ANSWERS ARE LISTED IN THE BACK OF THE BOOKLET UNDER CHAPTER 3.

CHAPTER 4

Pesticides And The Environment

Illinois is one of the leading states in both agricultural production and pesticide use. The latest data indicates that ninety-five percent of 11.7 million acres of corn crop was treated with herbicides and fifty-six percent of the crop was treated with insecticides. Ninety-six percent of the soybean crop was treated with herbicides, and only four percent of the 6.7 million acres was treated with insecticides. The amounts of toxic chemicals released into the environment have a potential for serious pollution of Illinois water resources.

Pesticide - An Environmental Pollutant

Pesticides become a hazard to the environment when the chemical moves off the target area. Wind (drift) can blow a pesticide off the target area during application. Runoff water can carry dissolved pesticides into water resources. Pesticides absorbed into soil particles can enter the water system by soil erosion. When a pesticide moves off the target area and into a water system, it can poison any number of living organisms. Knowledge of conditions and practices which contribute to water contamination by pesticides can help applicators minimize the hazard.

Drift. One hazard pesticides present to the environment during the process of application is drift. Pesticide drift is the movement of spray, dust, or chemical vapor away from the intended target. Drift can damage crops, injure livestock, pollute waterways, leave residues on crops and livestock, and poison humans. A drift hazard can be reduced significantly by following application procedures that reduce movement of the pesticide off the target area.

Drift occurs when pesticides are applied in turbulent air. Winds are a major cause of pesticide drift. Winds in excess of seven miles per hour are strong enough to cause considerable pesticide movement away from the target area. Air movements causing drift also occur when pesticides are applied under conditions of a temperature inversion. An inversion arises when there is a warm air mass above a cooler air mass. Inversions usually occur in early morning or late afternoon. Do not apply pesticides when winds exceed seven miles per hour or when a temperature inversion exists.

Droplet size is also significant in contributing to or preventing pesticide drift. Larger droplets weigh more than smaller droplets. Heavier droplets are less likely to be blown by wind. Nozzle pressure is a determinate of droplet size. High nozzle pressure reduces droplet size and increases the probability of pesticide drift. Never exceed the recommended nozzle pressure.

Runoff Water. Many pesticides have qualities which cause them to stick to small particles of soil. This quality is known as adsorption and is valuable for a number of chemicals to effectively do their jobs. Adsorption helps pesticides avoid polluting ground water. Adsorption complicates pesticide use when soil erosion occurs and the adsorbed pesticide moves out of the target area with the eroded soil. Damage to streams, rivers, and lakes results when contaminated soil particles release adsorbed pesticides into the water. The problem is especially critical because the smallest soil particles, the clay and humus

colloids, contain the highest amounts of adsorbed pesticide, and are the most easily eroded. Soil conservation practices will reduce the hazard of adsorbed pesticides contaminating water resources.

The highest potential for water pollution exists when the solubility of a pesticide is high or the soil characteristics are such that pesticides are not easily adsorbed. Pesticide solubility characteristics and soil properties such as pH, cation exchange capacity, moisture content, mineral clay content and organic matter, combine to control adsorption or solubility of a pesticide. Pesticides in runoff are substantial when a heavy rain immediately follows application, regardless of the adsorption potential of the soil-chemical system. Pesticide levels in runoff water are particularly high with non-incorporated pesticides. Sound pesticide management practices can minimize the hazard to the water resources. This depends primarily on applicators knowing the particular characteristics of the pesticide in use, the type of soil, and the weather conditions.

Sources of Dilute Pesticide Solutions

There are five major sources of surplus dilute pesticides. They are: container rinsate, equipment washing, pesticide spills, water from fires, and reconditioning operations.

Container Rinsate. The rinsing of pesticide containers can be a major source of excess pesticide solution if the rinsate is not used for mixing water in the spray tank. Triple rinsing, jet spray nozzle, or an equivalent cleaning method produces rinsate. All containers (1, 5, 30, and 55 gallon) must be rinsed. Each container

must be triple rinsed or equivalent immediately after it is emptied.

An unrinsed 5-gallon container has an average of two and one-half ounces of chemical concentration left in the container. These containers present a serious hazard to the environment. Runoff from the place of storage (individually or in stack) can pollute surface water. Groundwater contamination may occur if percolation is high. Chronic contamination from the area may result and harm the environment over a long period of time. Applicators can reduce the container hazard and get all the pesticide paid for by triple rinsing emptied containers.

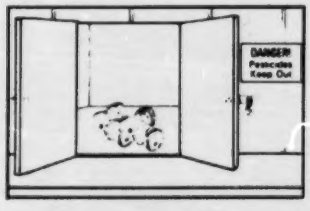
The triple rinse method involves the following procedures. Fill each container to one-fourth its volume and cap it. Swish the water around so that all sides get rinsed. Empty this rinsate (diluted pesticide) into the pesticide tank. Repeat this step twice. After three rinsings, puncture the can, top and bottom. The container is still dangerous. Store containers under lock and key until disposed.

Step 1. Empty pesticide from container.

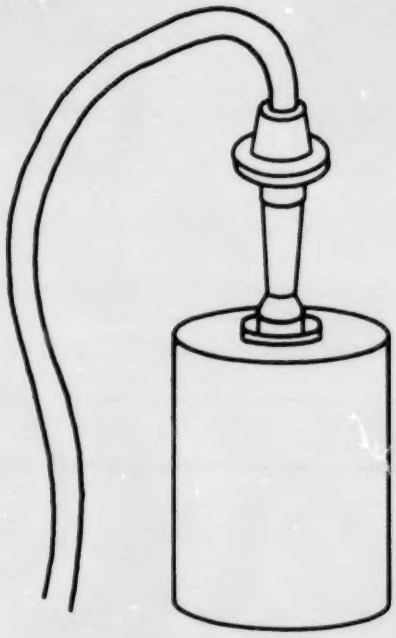
Step 3. Rinse the container.

Step 4. Repeat steps 1, 2, and 3 twice.

Step 2. Fill empty container with water to 1/4 volume and cap.



Step 5. Store container until disposed of properly.



The jet spray nozzle method, a container rinsing device, can rinse a five gallon liquid container in approximately thirty seconds using two and one-half gallons of water under 40 to 45 psi (normal water pressure). The container is emptied into the sprayer tank. The probe of the jet-spray nozzle is inserted into the bottom of the container. The jet-spray nozzle is activated when the container is empty. The jet spray slowly rotates back and forth through an arc of about 90 degrees. Rinse the container for 60 seconds, turn off the jet spray nozzle and dispose of the container once the rinsate has drained into the sprayer tank.

The rinsed containers can be crushed and disposed of in an approved landfill, delivered to a container collection point, or delivered to a recycling company.

Equipment Washing. The amount of pesticide solution left in spray equipment after application can vary from as little as one to five gallons. Large quantities of dilute pesticide solutions remaining in equipment when application is completed introduce difficult and costly disposal problems. Avoid having surplus pesticide in application equipment by mixing only what is needed for the job. Carefully select a pesticide registered for the pest

problem. Mixing the proper amount and the correct pesticides will avoid problems and reduce hazards associated with disposal of large quantities of dilute pesticides.

Equipment washing includes the cleaning of spray tanks, mixing tanks, holding tanks, trucks, and airplanes. The equipment should be washed off in an isolated area where contaminated water can be contained. The drainage system should collect the runoff water, and spills from tank rinsings. Pesticide application equipment must be thoroughly washed after use. The law requires rinsate from the equipment cleaning be treated as a concentrated pesticide for disposal purposes. Equipment that is cleaned will present the least hazard to humans and the environment.

Spills. In the event of a spill, protection of life (human, animal, and aquatic) is important. Keep all unauthorized persons out of contaminated area. Contain spills with soil or sand dikes to prevent spreading. Keep all but a minimum cleanup crew away from area and post warning signs. Spread adsorptive material very liberally over the pesticide spill. Remove adsorbent material and seal it in a drum. Spread a neutralizing compound over the area.

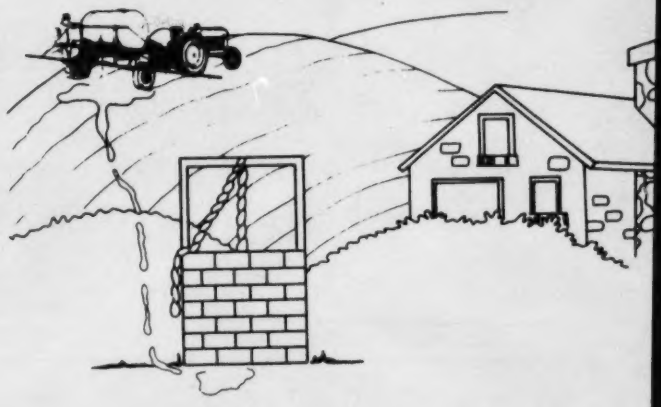
If uncertain what to use, contact the manufacturer or Illinois EPA. Do not use any water until the pesticide area has been neutralized. Afterwards, rinse area with water, collect the waste, and dispose of it as hazardous material.

Water from Fires. Water contamination from a fire associated with pesticide storage can create a large volume of hazardous waste. The hazardous waste must be contained and disposed of in an approved way.

Reconditioning or Recycling Operations. Once the containers have been returned to a recycling company the used containers are rinsed and burned-out prior to reuse. The wash water is classified as hazardous waste.

Disposal of Dilute Pesticide Solutions

A continuing threat to Illinois' clean water is the improper handling of surplus pesticides. Pesticides are capable of contaminating above ground and below ground water resources. Direct dumping of diluted and/or concentrated pesticides onto the soil surface can pollute wells and water supplies. Plants, animals, and humans in the area may also be adversely affected. Surface water



systems can be seriously polluted by runoff from these areas. Surface waters are contaminated by deposits of pesticide into ponds, lakes, and running water. Concentrations lethal to fish and other aquatic life can result from dumping dilute pesticide into water systems. Pesticide users must exercise safety and conduct practices which will not pollute water sources.

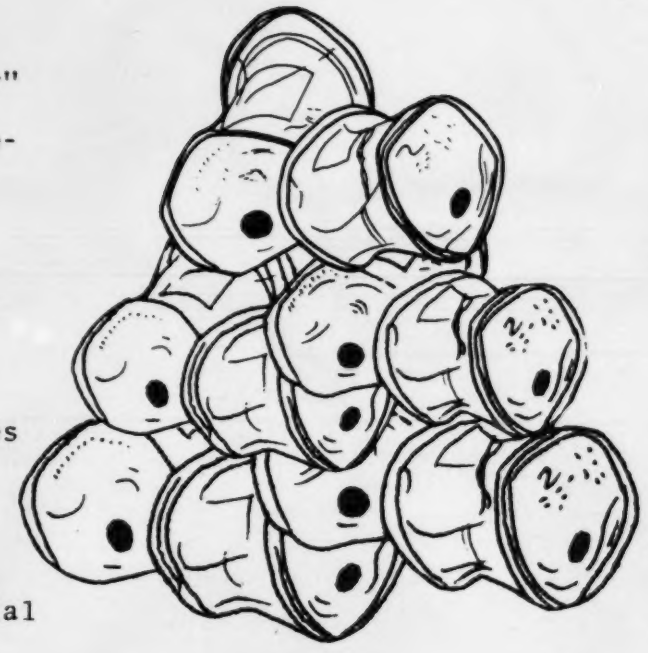
The U.S. EPA regulations require that dilute pesticides be treated as hazardous waste for disposal purposes. Applicators may use one of several approved practices to dispose of dilute pesticide solutions.

Diluent. The excess dilute pesticide can be further diluted and reapplied to the same target area if precautions are taken not to exceed the maximum rate established on the label. If excess pesticide mix cannot be reapplied to the field find an area where the same pest problem exists and apply the pesticide. Another recommended practice is to use the dilute pesticide mixture as a diluent for the next operation when further applications are planned.

Disposal Pit. A concrete-lined pit holds the rinsate solution until evaporation of the liquid waste. The dry waste remains in the pit until accumulation requires removal of this waste. The dry residual should be handled as hazardous waste.

Holding Tanks Using Chemical Detoxification. The problem with using chemicals to break down pesticides is that no one chemical is effective against all pesticides. Chemical reactions produced by this process can be as hazardous as the original pesticide.

Container Disposal



High levels of pesticide use results in large numbers of "empty" pesticide containers. One and one-half million five gallon metal pesticide containers are emptied each year in Illinois. Disposal of each container must be accomplished by a method that eliminates contamination hazards to humans, livestock, wildlife, fish, and water resources. Farmers, commercial applicators, and others who use pesticides are responsible for safe disposal of the container. Safe disposal methods are printed on each label. Directions for container disposal will vary with the pesticide and the type of container. Triple rinsing or the equivalent is required by law for general landfill disposal. The rinsed container can be crushed and disposed of in an approved landfill, delivered to a container collection point, or delivered to a recycling company. Contact the Illinois Regional Environmental Protection Agency (IEPA) for further information concerning collection sites and recycling companies.

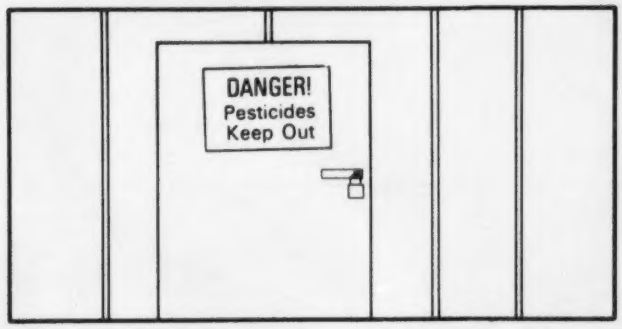
Storage of Pesticides

From the time pesticides arrive on a site until applied, a potential exists for escape of concentrated chemicals into the environment. Containers may spill or leak poisonous contents.

Children, unaware adults, pets, or livestock may enter storage areas and poison themselves or pollute the environment. Fire, explosion, or both can release pesticides as liquids or fumes covering large areas with toxic materials. Floods can wash over entire areas and remove everything in their path, including stored pesticides. Examination of storage hazards will give possible clues as to the safest location for a pesticide storage area.

Locking pesticides away reduces the risk of accidental poisoning to children, adults, and animals. Store pesticides according to label directions. Post weather resistant signs indicating Danger! Pesticides Keep Out of the storage area on all doors and windows of the storage structure. The chance of accidental poisoning is reduced when pesticides are securely locked and the area is posted with warning signs.

The escape of hazardous chemicals into the environment can be reduced by locating storage facilities downwind and downhill from residences, play areas, livestock areas, and water sources. Avoid storing pesticides where runoff can contaminate surface water or wells. Store pesticides for safety first, not convenience.



The storage facility itself should incorporate safety features. Ventilation fans, directed away

from plants, animals, and people, will reduce heat and fume concentration. It is highly recommended that fire fighting equipment, sprinkle systems, and fire resistant buildings be used. Store large quantities of adsorptive materials in the area to clean up spills. Have hydrated lime and sodium hypochlorite (bleach) on hand to neutralize pesticide spills. As a fire precaution, post a list of the chemicals contained within the storage structure outside the building and give a copy to the fire department.

KEY QUESTIONS

CHAPTER 4

1. Wind (drift) can blow pesticide off of the target area during _____.
2. Pesticides should not be applied if the wind is in excess of _____ miles per hour.
3. Damage to streams, rivers, lakes, and other water resources occurs when contaminated _____ particles release adsorbed pesticides into the water.
4. Pesticides in _____ is substantial when heavy rain follows application.
5. Sound pesticide _____ practices can minimize the hazard to the water resources.
6. Pesticide container _____ can be a major source of excess pesticide solution.
7. Applicators can reduce the container hazard and get all the pesticide paid for by _____ rinsing emptied containers.
8. An alternative to the triple rinse method of rinsing containers is the _____ _____ nozzle method.
9. Pesticide application equipment should be washed off in an isolated area where contaminated water can be _____.

10. The law requires rinsate from the equipment cleaning be treated as a _____pesticide for disposal purposes.
11. Pesticide spills must be contained with soil or sand _____ to prevent spreading.
12. If uncertain as to what neutralizing compound to use in cleaning up a pesticide spill, contact the _____or the Illinois EPA.
13. Concentrations lethal to fish and other aquatic life can result from dumping dilute pesticide into _____resources.
14. U.S. EPA regulations require that dilute pesticides be treated as _____waste for disposal purposes.
15. Excess dilute pesticide can be reapplied to the target area if the _____rate established on the label is not exceeded.
16. The recommended practice is to use the dilute pesticide mixture as a _____for the next application.
17. One and one-half million five gallon metal pesticide containers are emptied each year in _____.
18. Triple rinsing or equivalent is required by _____ for general landfill disposal.
19. The rinsed container can be crushed and disposed of in an approved _____, delivered to a container collection point, or delivered to a recycling company.

20. The chance of accidental poisoning is reduced when pesticides are _____and the area is posted with _____signs.

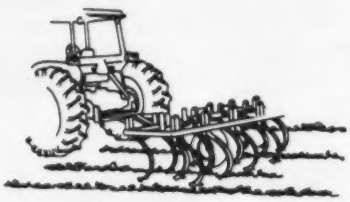
21. Do not store pesticides where _____can contaminate surface water and wells.

ANSWERS ARE LISTED IN THE BACK OF THE BOOKLET UNDER CHAPTER 4.

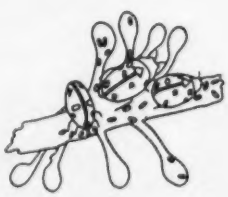
CHAPTER 5

Integrated Pest Management Practices

Integrated pest management (IPM) is the practice of utilizing several pest control methods to manage, not eradicate, pests. This may involve using cultural control, biological control, and/or chemical control (pesticides).



Cultural



Biological

Chemical

Integrated pest management can result in reduction of the amount of pesticides used in crop production. Reduction in amounts of pesticide used will reduce the potential contamination of Illinois water resources.

Integrated pest management (IPM) uses the best technique or combination of techniques that will hold pests below the point where they cause economic damage to the crop. The broad categories of techniques employed in any IPM program include cultural methods (environmental manipulations), biological control (natural enemies), and chemical control (pesticides) methods. Determination of the best technique

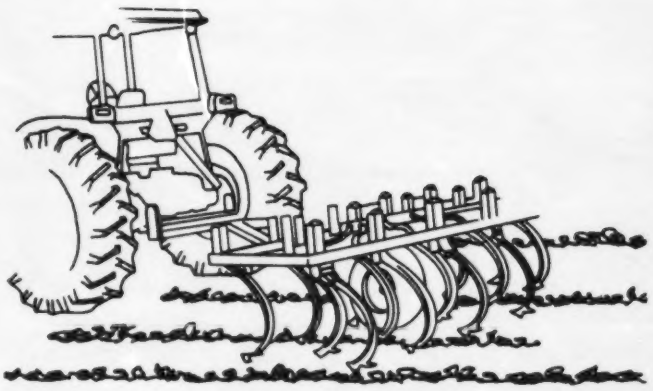
or combination of techniques resulting in economic control of a pest varies.

Cultural Control

Cultural control techniques are also known as environmental manipulation. There are two general objectives of cultural control. One is to create conditions which do not favor the establishment, growth, or spread of the pest. The other is to create conditions which favor the crop or natural enemies of the pest. The practices employed include: exclusion of the pest, disruption of the pest life cycles, and the removal or destruction of the normal habitats of the pest. These are techniques already practiced by today's farmer. Expanding the use of these techniques may require a modification of current agricultural production practices. Cultural control methods are often the easiest, safest, and most profitable pest control techniques a farmer can apply, and further expanded use is encouraged.

Techniques which exclude pests prevent or reduce the likelihood of a pest becoming established and causing serious damage. Farmers who sow weed-free seed exclude noxious pests from their fields. Sowing disease-free seed and utilizing disease-resistant varieties or varieties tolerant of insects are recommended practices. Altering planting dates or growing early maturing varieties moves crop growth patterns out of synchronization with a pest species' life cycle and can eliminate the pest as a significant problem. The local county extension advisor can serve as a valuable resource in identifying the varieties most suited for the local community.

Soil cultivation is a cultural process which creates favorable conditions for plant growth and destroys growing weeds. Soil cultivation can be used to disrupt the insect life cycles. For example, a substantial reduction in corn earworm populations can be achieved by spring plowing. This practice can disrupt the earworm life cycle so severely that up to 98% mortality can be inflicted. Not all soil inhabiting organisms are this susceptible to spring plowing.



Severity of the problem should be assessed before deciding to cultivate.

Crop sanitation is another method which excludes a pest from the crop environment. Many types of pest survive the winter months within fallen leaves and crop residues. From these "hiding places", the pest emerges when conditions are favorable and damage crops. The removal of suckers and prunings, and fall mowing in orchards, nurseries, and arbors are recommended to reduce the potential for diseases and/or insects. Plowing under crop residues may be recommended to control some pests <u>if soil erosion is not a problem</u>. Burning will also destroy wintering habitats, but the air pollution associated with burning makes it less of an acceptable practice. Sanitary procedures reduce the amount or number of pests available to reinfest crops in subsequent seasons. The practice of

santitation should be maintained whenever a pest is susceptible to the cultural control method.

Crop rotations are valuable in minimizing pest problems. By alternating the crop grown, pests exist at lower population levels because there is insufficient nutrition available to sustain the large pest population for a given crop. The rotation must include resistant plant species frequent enough to inhibit pest growth. Another likely benefit of crop rotations is improvement of the soil.

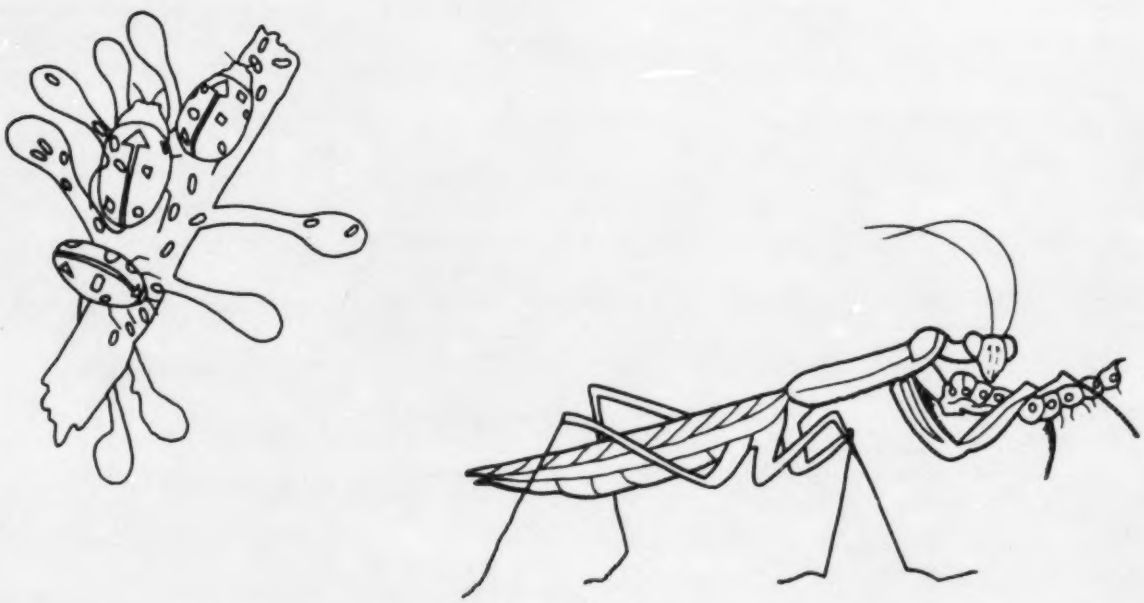
The spacing of crops (crop density) can have a monumental influence in pest development. Some effects can be advantageous while others can be harmful. A crop with a dense canopy intercepts sunlight well above the field floor. Lacking this essential growth component, weeds are often uncompetitive with the crop and present little or no problem. This same canopy which is affecting weed control is simultaneously creating a microenvironment which reduces air movement and holds high levels of humidity long after rainfalls. These conditions are favorable to disease growth. When disease is a serious problem because of conditions of extended high humidity, consideration should be given to creating more air movement. Though this may reduce the potential yield, economic gains may be made in reducing the percent of the crop lost to the disease.

Cultural control practices that adversely affect pests and benefit crops or natural enemies of pests are useful in reducing the need for pesticides. Cultural controls are one technique employed in

IPM programs. The philosophy of IPM is to use the best technique or combination of techniques that will achieve adequate pest control.

Biological Control

Biological control is gaining importance as a means of pest control. Traditionally, biological control has meant the introduction of a predatory organism against a pest species. The meaning of biological control has recently been expanded to include a wide variety of non-chemical pest control techniques. Biological control will be defined as the use of one organism for the control of another. Primary emphasis is on insect control, though other pests are susceptible to biological control techniques.



The science and technology of biological control has been greatly improved. Pests as diverse as insects, fungi, and some vertebrae can be biologically controlled or regulated. Organisms used in the control processes are equally diverse. Beneficial fungi, bacteria, viruses, insects, mites, nematodes, and some vertebrae are all used to gain control over crop pest populations.

Pest outbreaks in agricultural crops are attributable to man's changes in the natural environment for cropping purposes. To understand what these modifications are, knowledge of a few basic concepts about the environment is required. Any "system" in the environment may be defined as an ecosystem. Within any ecosystem is a community of populations. Populations are made up of individual organisms in a species. Diverse communities are those with a large number of populations. Simple communities have a relatively small number of populations. Diverse communities are more stable than simple communities. This stability, or resistance to change, exists because there is a range of natural control mechanisms. Agricultural ecosystems are simple, and therefore, unstable because there is a limited number of control mechanisms in them. Elimination of suitable habitats and exclusion of beneficial insects by pesticide use cancels out natural control mechanisms that are in the environment.

Biological pest control can be very difficult to achieve. The life cycles of predators and pests must be synchronized. Areas may need to be maintained as suitable habitats for predators or parasites to reproduce or overwinter. Insect predators may require alternative host species to survive times of low prey populations.

In some instances, a complex of predators and parasites may need to be established against pest species for effective biological control. Once the biological control practice is established, it is a most effective measure of pest control within the environment.

Primary consideration should be given to the conservation of existing natural enemies. Conservation is the planned practices employed to protect and maintain natural enemy populations. Conservation practices include cultural methods such as maintaining suitable habitats for natural enemies, maintaining alternative food sources, and exercising care and caution when using pesticides so that beneficial insects will not be harmed. Conserving the beneficial organisms will reduce the use of chemical pesticides.

Reestablishing beneficial insects in an ecosystem can be accomplished by releasing the insects into the environment. Three general strategies are used in insect releases. The first is an inoculative release made with the anticipation of permanent survival for the predator and regulation of the pest at a lower density. Second, inoculative releases are made with the anticipation of predator survival for a limited number of generations and regulation of the pest below the economic threshold for that time. The third strategy is the release for rapid host mortality and no expectation of predator survival for long-term control. The most appropriate means of selection is based on the agronomic practices being conducted to control the pests.

The quality of potential control by natural enemies can be attributed to five characteristics. First, is the ability to adapt to changing physical conditions. Second, is the ability to find

prey (searching capacity). Third, is the rate of increase of the predator relative to the prey. Fourth, is the quantity of prey consumed. Fifth, is other considerations such as host specificity, life cycles, and the ability to survive host-free periods. The better matched the predator or parasite is with the pest species, the greater the degree of pest control.

Another opportunity exists to inflict damage to pest populations without using pesticides. Like many living organisms, insects are subject to infection by diseases. Virus, fungi, and bacteria are all capable of creating diseases among insects. These events occur regularly in nature. Infecting insects with disease is a process being developed for the purpose of pest control.

Chemical Control

The use of chemical pesticides has resulted in economic benefits to those involved in agricultural production and to the consumer. Pesticides have promoted higher quality crops, improved crop yields, and have helped improve land management. The need for more intensive farming on decreasing acreage in the United States demands that modern agriculture be highly efficient. Chemical pesticides serve an important role in reducing pest problems in agricultural production.

Pesticides are economical, returning $4-5 for each dollar invested. Pesticides are fast acting, killing a large portion of a pest population rapidly when economic damage is threatened. Some pests can only be controlled by the use of chemicals. When cultural and biological control measures have been applied and the pest population continues to increase, a pesticide may be the only practical solution for pest control. Pesticides are both convenient and desirable for crop protection when the need arises.

Continued use of pesticides must be accomplished in a more selective manner than past and present use patterns. Pesticides used against pest population should be toxic to the pest species and nontoxic to non-target organisms. The timing of pesticide application must be synchronized with the pest level that will cause economic damage. Pesticide applications should contact the target species and minimize contact with a non-target organism. Selective use of pesticides will reduce the hazards to the environment and minimize the negative impact on non-target organisms.

Ideally, when a pesticide application becomes necessary a chemical toxic to the pest species and harmless to non-target organisms would be used. A number of pesticides achieve this

degree of specificity. If such selective toxic pesticides are available, applicators are encouraged to make use of them.

Trap crops, lights, or attractants to lure pests to a particular area to be sprayed can reduce the amount of pesticide needed and minimize harm to the environment and non-target species. This reduction in pesticide use will decrease environmental pollution, minimize adverse effects on natural enemies, reduce secondary pest outbreaks, and slow the development of genetic resistance in the pest species. Treating seeds with pesticides in furrow applications at very low rates and banded treatments yield similar results to broadcast applications of the same chemical at higher rates.

The past success of pesticides used in agriculture led to overuse of some pesticides. The belief that repeated applications of toxic chemicals would eventually rid farmers of pest problems was widely accepted. The strategy of overkill resulted in contamination of water resources (rivers, lakes, streams, ponds), destruction of non-target organisms, secondary pest outbreaks, and development of genetic resistant pest populations. The philosophy of overkill is not environmentally safe, nor is it economically sound.

The continued use of chemical pesticides to control crop threatening pest outbreaks is recommended. Pesticide use must be a part of an overall plan to control pests. Use biological and cultural methods of pest control before using chemicals. When pesticide use becomes necessary, the user must get the maximum benefit with minimum environmental damage. Integrate selectivity into the pesticide program. Realize that economical control does not require total destruction of the pest--man can live with a pest population

below damaging proportions. Observance of these guidelines can reduce pesticide use. Wise use of pesticides will help agriculture prosper and reduce pesticide pollution potential in Illinois water resources.

KEY QUESTIONS

CHAPTER 5

1. Integrated pest management is the practice of utilizing several pest control methods to _____ pests.
2. IPM uses the best technique or combination of techniques that will hold pests below the level where they cause _____ damage to the crop.
3. Sowing disease-free seed and utilizing disease-resistant varieties or varieties tolerant of insects are _____ practices.
4. Soil _____ is a cultural process which creates favorable conditions for plant growth and destroys growing weeds.
5. Plowing under crop residues may be recommended to control some pests if _____ _____ is not a problem.
6. Cultural control practices that adversely affect pests and benefit crops or natural enemies of pests are useful in reducing the need for _____.
7. In this booklet, biological control was defined as _____.
8. Insect predators may be used to control _____ harmful to a specific crop.
9. Chemical _____ serve an important role in reducing pest problems in agricultural production.

10. The timing of pesticide _____ must be synchronized with the pest level that will cause economic damage.
11. When pesticide use becomes necessary the user must get maximum benefit with _____ environmental damage.

ANSWERS ARE LISTED IN THE BACK OF THE BOOKLET UNDER CHAPTER 5.

KEY QUESTIONS ANSWER SHEET

CHAPTER 1

1. agricultural
2. consumer
3. environment
4. water
5. quality
6. pesticides
7. water

CHAPTER 2

1. chemicals
2. insecticides
3. plant
4. diseases
5. pollution
6. lethal
7. inhalation
8. high
9. ingestion (oral)
10. ingestion
11. toxicity
12. contamination
13. Inhalation
14. residues

CHAPTER 3

1. pest
2. label's
3. environment
4. restricted
5. diluted
6. mixing
7. commercial
8. surface
9. control
10. water

CHAPTER 4

1. application
2. seven
3. soil
4. runoff
5. management
6. rinsate
7. triple
8. jet spray
9. contained
10. concentrated
11. dikes
12. manufacturer
13. water
14. hazardous
15. maximum
16. diluent
17. Illinois
18. law
19. landfill
20. locked, warning
21. runoff

CHAPTER 5

1. manage (or control)
2. economic
3. recommended
4. cultivation
5. soil erosion
6. pesticides
7. the use of one organism for the control of another
8. insects
9. pesticides
10. application
11. minimum

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